Population Dynamics Team
NOAA BEAUFORT LABORATORY

Stock Assessment: the Challenge

With the world's fish stocks increasingly depleted, stock assessment scientists throughout NMFS are re-doubling efforts to provide accurate and timely scientific advice to fishery managers. At the NOAA Beaufort (N.C.) Laboratory, the Population Dynamics Team conducts research on a number of fronts to support assessment and management of our Nation's living marine resources.

No "cookbook" exists for conducting stock assessments. Because of the different biological and anthropogenic factors involved in each fishery, investigators must explore and develop models suitable for each stock and that can address the concerns of management bodies. Often, existing methods and tools can be used; but in many cases, methods must be extended or revised or new analytical techniques developed to accommodate the available data and resources.

Most importantly, data, methods, and models must support the goals of the Sustainable Fisheries Act: to maximize the benefit to the Nation while conserving our living resources to assure their persistence for future generations.

Stock Assessment: Supporting Councils and Commissions

Management of fish and shellfish stocks is presently controlled by Fishery Management Councils in Federal waters (outside three miles) and by the states in coastal waters (inside three miles). Where interstate fisheries are pursued in coastal waters, management is often delegated to interstate commissions, such as the Atlantic States Marine Fisheries Commission, which manages interstate coastal stocks from Florida to Maine.
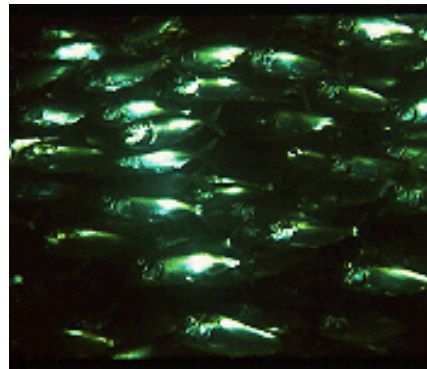
A school of Atlantic menhaden

The research of the Population Dynamics Team is directly aimed at the stock assessments required by Councils and Commissions. (This research includes both assessments themselves and studies to improve biological and statistical knowledge of population dynamics.)

The following species are among those for which assessments are conducted by the Population Dynamics Team, often in cooperation with state, Council, and Commission biologists:

- Atlantic menhaden, *Brevoortia tyrannus*
- gulf menhaden, *Brevoortia patronus*
- black sea bass, *Centropristis striata*
- red drum, *Sciaenops ocellatus*
- red porgy, *Pagrus pagrus*
- weakfish, *Cynoscion regalis*
- wreckfish, *Polyprion americanus*

Because Team members are among the more quantitatively oriented scientists at the Center, they frequently collaborate on statistical, modeling, and sampling problems with members of other Teams.

Monitoring Fisheries: A Unique Resource

Data needed for assessments are obtained from several sources, with statistical sampling of fishery landings among the most important. Team members have sampled Atlantic and gulf menhaden landings since 1955 and 1964, respectively, for size and age composition. These species support two of the largest fisheries by volume in the U.S., and supply fish-derived products for use as animal feed, in human health supplements, and in other products.

The menhaden program within the Population Dynamics Team is one of the oldest continuously extant fishery research programs in the U.S. Biological and landings data have been coherently collected for over four decades; the resulting data sets are a valuable resource for managing menhaden fisheries and as a benchmark of long-term population dynamics of marine fish. This data resource is unusual in its length and consistency, and unique in that the same personnel have been reading ages from menhaden scales for over thirty years.

A Team member sampling Atlantic menhaden in Reedville, Virginia

Recently, logbook data from the purse-seine fleet were computerized to help refine catch estimates. The logbook information has also been extremely useful in conveying menhaden catch and fishing by location

to local, state, and federal officials. In a continuing effort to share the products of research with the public, the Team releases monthly catch and age composition updates, annual catch forecasts, and scientific publications about the fish and fisheries.

Understanding Life Histories of Important Resource Species

The biological study of menhaden was an early focus of the Team's research. Through time, other species have also been studied, always with the aim of better understanding population characteristics like growth, fecundity, and mortality, as these characteristics are key issues in management for sustainable yield.

Purse seiners encircling a school of Atlantic menhaden

For example, an early question was whether Atlantic menhaden on the East coast of the U.S. were from a single biological population. Tagging and growth studies by Team members in the 1960's and 1970's revealed that this was indeed the case. Tagging also provided a wealth of information on migratory routes and better estimates of natural and fishing mortality rates. Other Team studies have shed light on spawning periodicity and frequency and the importance of estuaries as nursery areas for young menhaden.

Menhaden are not the only species studied by Team members. Research has included the following species:

- Atlantic thread herring, *Opisthonema oglinum*
- cobia, *Rachycentron canadum*
- pigfish, *Orthopristis chrysoptera*

- striped mullet, *Mugil cephalus*

These species support important commercial and recreational fisheries along the southeastern coast of the United States.

Improving Analytical Techniques

The models and analytical techniques used in stock assessment are under constant refinement and study. A particular area of interest within the Team is application of stock–production models, which are simple models in wide use for estimating maximum sustainable yield (MSY). Team scientists are investigating the relative benefits of using simpler or more flexible forms of this type of model.

This research has found application in assessment of local species, such as Atlantic menhaden, and species managed on an international scale, such as the north Atlantic stock of swordfish, which is managed by the International Commission for the Conservation of Atlantic Tunas, located in Madrid.
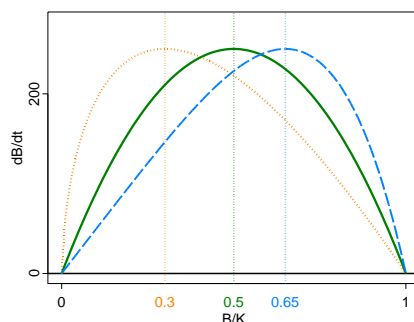
Alternative models of fish-stock productivity, derived from ecological principles.

Statistical uncertainty is associated with all aspects of assessment work, and indeed is inherent to all analysis of living marine resources. Sources of uncertainty include the data themselves, limited knowledge of some population parameters, and uncertainty about the best structure for models used to describe population dynamics. In presenting fish stock assessments, it is important that uncertainty be presented realistically

and in a way that clearly demonstrates the likely consequences of management action (or inaction).

Propagation of uncertainty and presentation of assessment results including uncertainty are active lines of research for population dynamicists in NMFS and other marine resource agencies worldwide. Within the Team, research is taking place on the use of bootstrapping and other nonparametric methods for carrying uncertainty through assessments. Replacement of parametric recruitment models by the nonparametric "event–tree" approach has provided a robust method for simulating the effects of alternative management strategies through time.

Swordfish of the north Atlantic stock

Like all aspects of the Team's work, research on assessment methodology uses advanced scientific techniques to serve the public good.

Team Members

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